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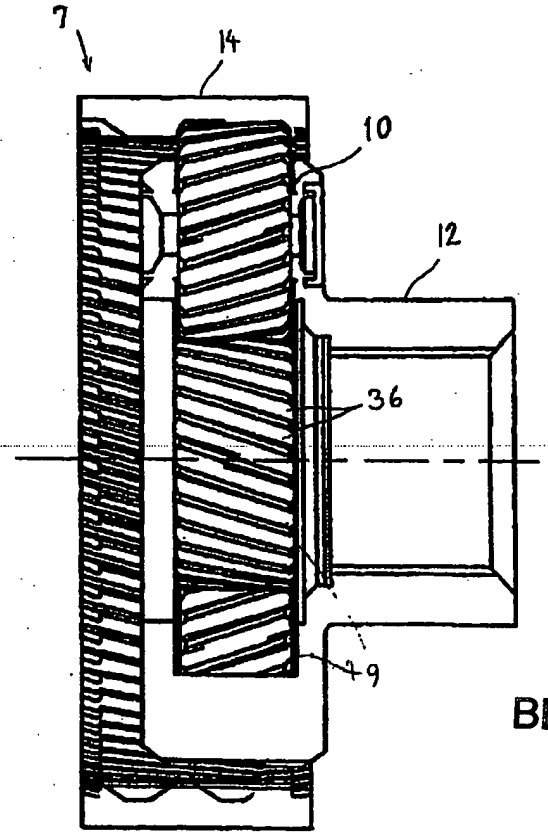
(54) Title: RANGE GEARBOX



(57) Abstract: The invention relates to a range gearbox of the planetary type, intended to be connected to a basic gearbox. The ring gear (14) of the planetary gear (7) is connected non-rotatably to a coupling sleeve (18), by means of which the ring gear can be locked either to a coupling ring (25) fixed to the rear housing end wall of the gearbox or to a coupling ring (21) connected to the planet wheel carrier (12), or alternatively a coupling connected to an input shaft (5). The coupling sleeve displaces the ring gear axially during the coupling movement. In order to facilitate this coupling movement, the interacting tooth faces of the planetary gear are angled in such a manner in relation to the longitudinal axis of the input shaft and the output shaft that an axial force arises on the ring gear when the speed of the latter changes during synchronizing. This force tends, at least on shifting to the low range position, to move the ring gear in the same direction as the external shifting force and thus augments the latter.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

TITLE

Range gearbox

FIELD OF THE INVENTION

The present invention relates to a range gearbox for motor vehicles, intended to be connected to the output side of a basic gearbox and comprising a planetary gear, enclosed in a housing, with a sun wheel which is arranged on an input shaft and engages with planet wheels, which planet wheels are carried by a planet wheel carrier connected to an output shaft and engage with an axially displaceable ring gear which, by coupling means, is lockable either in a first coupling position in which it is connected non-rotatably to the housing in order to establish gearing between the input shaft and the output shaft, or in a second coupling position in which it is connected non-rotatably to the input shaft or the output shaft in order to establish direct drive between the shafts.

BACKGROUND

Vehicle transmissions consisting of a basic gearbox and a range gearbox coupled to the output side thereof are common, above all in heavy-duty vehicles, in order to provide a large number of gearings and thus make it possible to drive within a speed range favorable to the engine when the vehicle is driven at varying speed and under varying load. A range gearbox is usually of the two shift type, which means that the number of possible gear ratios is doubled when a range gearbox is coupled together with a main gearbox. In one of the two gear ratios occurring in a range gear arrangement, the input shaft is connected to the output shaft, and no gearing takes place in the range gearbox. This position is usually referred to as the high range. In the other gear ratio, the input shaft is connected to the output shaft via a sun wheel, planet wheel and ring gear

arrangement, and gearing between the input and output shafts takes place. This position is usually referred to as the low range.

A range gearbox of the type described in the introduction is known from, for example, GB 2151316, which comprises a sun wheel connected rigidly to the input shaft, and a planet wheel carrier connected rigidly to the output shaft. The planetary gearbox also comprises an axially displaceable ring gear which, by coupling means, is lockable either against rotation relative to said housing in order to establish gearing between the input shaft and the output shaft, or against rotation relative to the shafts in order to establish direct drive between the input shaft and the output shaft.

It is desirable that the shifting movement between low range and high range can be performed as rapidly and smoothly as possible, so that the speed of the vehicle is not reduced unnecessarily during the shifting operation, for example if shifting takes place on an upward gradient. Although shifting is pneumatically assisted, the mass moment of inertia to be accelerated during synchronizing is relatively great. Moreover, the ring gear and associated coupling means are to be moved during the shifting operation, from one coupling position to the other.

DISCLOSURE OF THE INVENTION

One object of the present invention is to produce a range gearbox of the type indicated in the introduction, which facilitates shifting from one coupling position to the other in such a manner that shifting can take place more rapidly, or alternatively by means of simpler operating means, in particular to low range which is the shift which takes the longest time, or alternatively requires the most force.

To this end, the range gearbox according to the invention is characterized in that the interacting tooth faces of the planetary gear are angled in such a manner in relation to the longitudinal axis of the input shaft and the output shaft that an axial force arises on the ring gear when the speed changes during synchronizing, and in that this force, at least on shifting to the low range position, tends to move the ring gear in the same direction as the external shifting force.

Preferred embodiments are indicated in the dependent claims.

BRIEF DESCRIPTION OF FIGURES

The invention is described in greater detail below with reference to illustrative embodiments shown in the accompanying drawings, in which

FIG 1 is a longitudinal section through the upper half of a range gearbox designed according to known art connected to a basic gearbox, and

FIG 2 shows a section through a sun wheel designed according to the invention, in which the helical tooth can be clearly seen.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

The range gearbox shown in part in Figure 1 corresponds to the construction disclosed in GB 2151316. Reference number 1 therefore designates the rear part of the housing of a basic gearbox, to which a flange 2 on a forwardly open housing 3 of a range gearbox is securely bolted. The rear end wall 4 of the housing 1 at the same time forms the front end wall of the range gearbox housing 3. The basic gearbox has an output shaft 5 which is mounted in a bearing 6 and projects into the housing 3 of the range gearbox. The shaft 5 forms the input shaft of the range gearbox, which shaft is coupled, via a planetary gear designated generally by

7, to an output shaft 8 provided with a flange for connection to the propeller shaft of the vehicle.

The planetary gear 7 comprises a sun wheel 9 which is connected rigidly to the input shaft 5 and engages with planet wheels 10 which are mounted on spindles 11 borne by a planet wheel carrier 12 which in turn is, via a spline joint 13, fastened non-rotatably on the output shaft 8. The planet wheels 10 engage with a ring gear 14 which has internal splines 15 in engagement with external splines 16 on an annular flange 17 which is made in one piece with a coupling sleeve 18. A locking ring 19 in a groove in the ring gear fixes the parts axially. The sleeve 18 is axially displaceable by means of a shift fork (not shown) coupled to the gear-shifting mechanism of the vehicle.

The coupling sleeve 18 has internal teeth 20 which, in the position shown in the figure, engage with corresponding teeth on a coupling ring 21 which, via a spline joint 22, is connected non-rotatably to the hub of the planet wheel carrier 12. The coupling ring 21 is designed with a synchronizing cone 23 which bears a synchronizing ring 24 in engagement with the teeth 20 of the coupling sleeve 18. A corresponding toothed coupling ring 25 with a synchronizing cone 26 bearing a synchronizing ring 27 is fixed to the rear end wall of the range gearbox 3 by an annular plate 28 which, with external teeth 29, engages with teeth 30 formed on the inside of the housing 3 and, with internal teeth 31, engages with the teeth of the coupling ring 25.

The teeth 20 of the coupling sleeve 18 have recesses 32 and 33 intended to receive an annular spring 34 which is arranged between the synchronizing rings 24 and 27 and the function of which is to transmit the pressing force from the sleeve 18 to the synchronizing rings during shifting. In principle, the recesses 32 and 33 form a pair of annular grooves between which the spring

34 is moved during shifting, the spring being compressed by the ridge 35 formed between the recesses or grooves during the shifting movement.

Figure 2 shows a sector of a ring gear 14 designed according to the invention, with a planet wheel 10 engaging in the ring gear. It can be seen that the interacting tooth faces of the planetary gear are angled in relation to the longitudinal axis of the input shaft and the output shaft. By virtue of this oblique angling of the teeth, the transmission noise generated by the mutual interaction of the teeth can be reduced. Moreover, the angling of the tooth faces gives rise to axial forces in the planetary gear.

The sun wheel 9 and the planet wheel carrier 12 are locked in the axial direction in the range gearbox, while the ring gear 14 is displaceable in the axial direction. The axial forces generated by the rotation of the planetary gear will therefore act on the ring gear. In the illustrative embodiment shown, the sun wheel is assumed normally to rotate clockwise, seen in the direction from the basic gearbox. The angling of the sun wheel teeth 36 is carried out in such a manner that they are angled from left to right seen in the direction from the basic gearbox.

During synchronizing, the rotation speeds of the ring gear, the planet wheels and the input shaft change. Owing to the mass inertia of these components, a torque is required for this change in speed. This synchronizing torque is brought about in the friction surfaces in the synchronizing unit when external shifting force is applied. A portion of the synchronizing torque is used for changing the speed of the planet wheels and the input shaft. This portion is transmitted in the tooth engagement of the planetary gear. The teeth in the planetary gear are angled in relation to the longitudinal axis of the input shaft

and the output shaft, what are known as helical teeth. During synchronizing, an axial force then arises on the ring gear. According to the invention, the angling of the teeth is in such a direction that the axial force which occurs on the ring gear augments the external shifting force. In this way, synchronizing and shifting are facilitated.

In the position of the coupling sleeve 18 shown in Figure 1, the ring gear 14 is locked against rotation relative to the planet wheel carrier 12 by virtue of the fact that the teeth of the coupling sleeve engage with the teeth of the coupling ring 21. The planetary gear is therefore locked in the high range position, direct drive between the input shaft and the output shaft being obtained.

When shifting to the low range position is to take place, the coupling sleeve 18, and with it the ring gear 14 as well, is displaced to the right in Figure 1. The sleeve 18 is then first disengaged from the teeth of the coupling ring 21. After a certain displacement distance, the annular spring 34 comes into contact with the opposite synchronizing ring 27 and presses it against the cone 26 of the coupling ring 25, braking of the coupling sleeve 18 and the ring gear 14 then being initiated. When the ring gear is braked, the planet wheels and the input shaft are accelerated via forces from the ring gear teeth, which results in an axial force which is directed to the right in Figure 1, that is to say the ring gear tends to move toward the braking cone 26 of the coupling ring 25. In this connection, the braking of the ring gear is speeded up, so that it is synchronized more rapidly with the coupling ring 25. During the continued displacement of the sleeve 18, the spring 34 is compressed by interaction between the inclined edge surfaces of the groove 33 and the spring 34 and is finally displaced over the ridge 35 to the groove 32. In this position,

the synchronizing work is finished, and the coupling sleeve 18 can be brought into engagement with the coupling ring 25 in order to lock the ring gear 14 in relation to the housing.

When shifting from the low range position to the high range position is to take place, the coupling sleeve 18, and with it the ring gear 14 as well, is displaced to the left in Figure 1. The sleeve 18 is then first disengaged from the teeth of the coupling ring 25. After a certain displacement distance, the annular spring 34 comes into contact with the opposite synchronizing ring 24 and presses it against the cone 23 of the coupling ring 21, acceleration of the coupling sleeve and the ring gear then being initiated. When the ring gear is accelerated, the planet wheels and the input shaft are braked via forces from the ring gear teeth, which results in an axial force which is directed to the left in Fig. 1, that is to say the ring gear tends to move toward the accelerating cone 23 of the coupling ring 21. In this connection, the acceleration of the ring gear is speeded up, so that it is synchronized more rapidly with the coupling ring.

During the continued displacement of the sleeve 18, the spring 34 is compressed by interaction between the inclined edge surfaces of the groove 32 and the spring 34 and is finally displaced over the ridge 35 to the groove 33. In this position, the synchronizing work is finished, and the coupling sleeve 18 can be brought into engagement with the coupling ring 21 in order to lock the ring gear 14 in relation to the planet wheel carrier, that is to say corresponding to the position shown in Figure 1.

The invention is not to be considered as being limited to the illustrative embodiments described above, but a number of further variants and modifications are possible within the scope of the patent claims below.

In the illustrative embodiment described shown in Figure 2, the sun wheel normally rotates clockwise, seen in the direction from a basic gearbox interacting with the range gearbox. It is of course also possible to adapt the invention to a sun wheel which normally rotates counterclockwise, the angling of the tooth faces then also running the opposite way.

PATENT CLAIMS

1. A range gearbox for motor vehicles, intended to be connected to the output side of a basic gearbox and comprising a planetary gear (7), enclosed in a housing (3), with a sun wheel (9) which is arranged on an input shaft (5) and engages with planet wheels (10), which planet wheels are carried by a planet wheel carrier (12) connected to an output shaft (8) and engage with an axially displaceable ring gear (14) which, by coupling means, is lockable either in a first coupling position in which it is connected non-rotatably to the housing in order to establish gearing between the input shaft and the output shaft, or in a second coupling position in which it is connected non-rotatably to the input shaft or the output shaft in order to establish direct drive between the shafts, characterized in that the interacting tooth faces of the planetary gear are angled in such a manner in relation to the longitudinal axis of the input shaft (5) and the output shaft (8) that an axial force arises on the ring gear (14) when the speed changes during synchronizing, and in that this force, at least on shifting to the low range position, tends to move the ring gear in the same direction as the external shifting force.

2. The range gearbox as claimed in claim 1, characterized in that the ring gear (14) is connected non-rotatably to a coupling sleeve (18) which is arranged concentrically with the output shaft and serves as a ring gear carrier.

3. The range gearbox as claimed in claim 2, characterized in that the coupling sleeve (18) engages in its said first position with a first coupling ring (21) which is fixed in relation to the planet wheel carrier (12) and in the second coupling position with a second coupling ring (25) which is fixed relative to the housing (3).

4. The range gearbox as claimed in claim 3, characterized in that the coupling rings (21, 25) are designed with mutually facing synchronizing cones (23, 26) which each interact with their respective synchronizing ring (24, 27) engaging with the coupling sleeve (18).

5. The range gearbox as claimed in claim 4, characterized in that the synchronizing rings (23, 26) can be pressed against the respective synchronizing cone (24, 27) by means of an annular spring (34) which is arranged between the cones and, in one coupling position, is accommodated in a first internal annular groove (32) in the coupling sleeve (18) and, when the coupling sleeve is displaced into the other coupling position, is displaced over to a second internal groove (33) in the sleeve by the synchronizing ring which is active in the second position.

6. The range gearbox as claimed in any one of claims 2-5, characterized in that the coupling sleeve (18) has an annular flange (17) with external splines (16) which engage with internal splines (15) on the ring gear (14), and in that the coupling sleeve is axially fixed relative to the ring gear by means of a locking ring (19) accommodated in a groove in the ring gear.

7. The range gearbox as claimed in claim 6, characterized in that extension of the teeth in the ring gear (14) is utilized for splines for rotational locking of the ring gear with the coupling sleeve.

8. The range gearbox as claimed in any one of claims 1 to 7, characterized in that the normal rotation direction of the sun wheel (9) is clockwise, seen in the direction from a basic gearbox interacting with the range gearbox, the tooth faces of the sun wheel (9) being directed to the right when the sun wheel is observed along its axis of rotation.

FIG.1

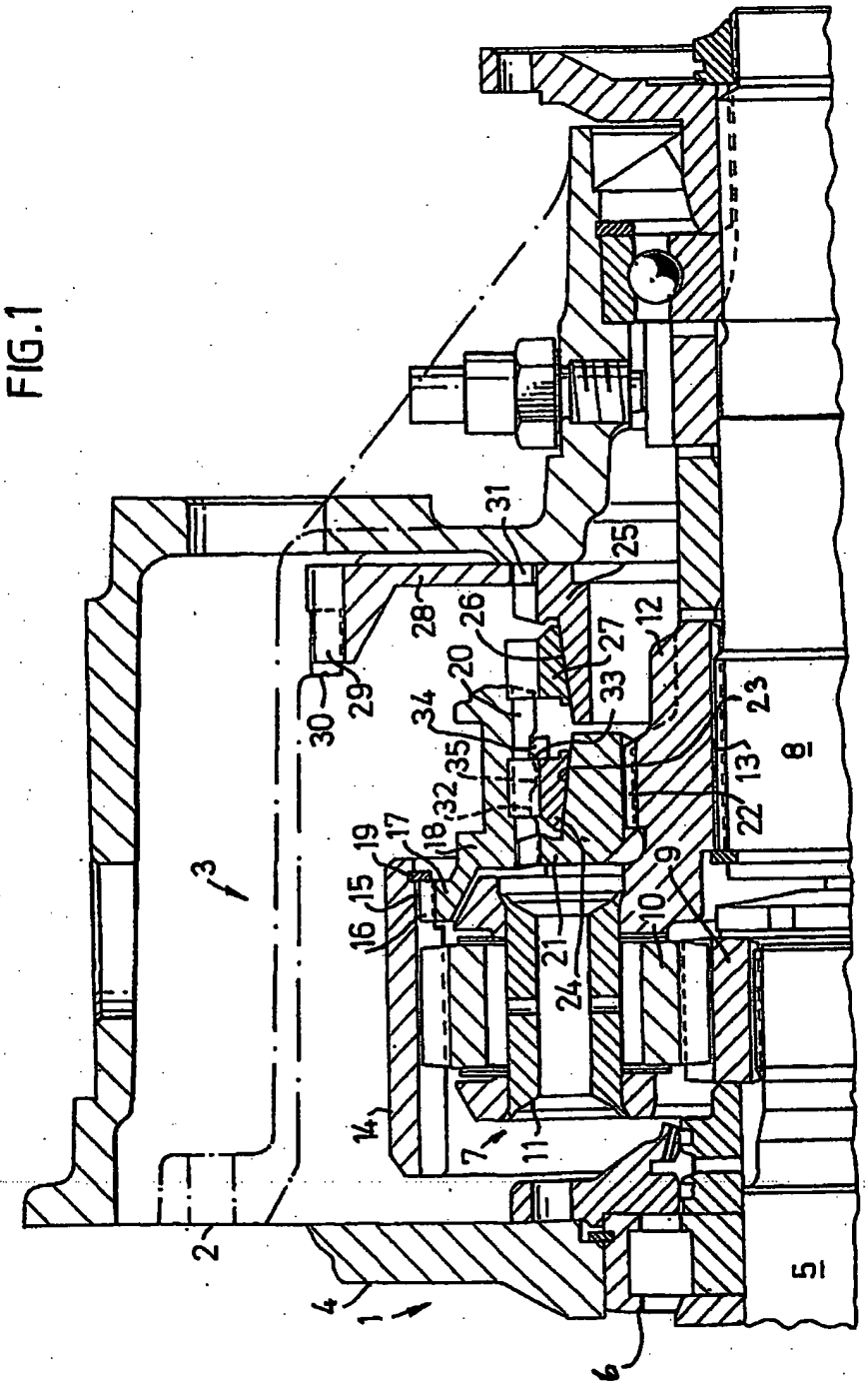
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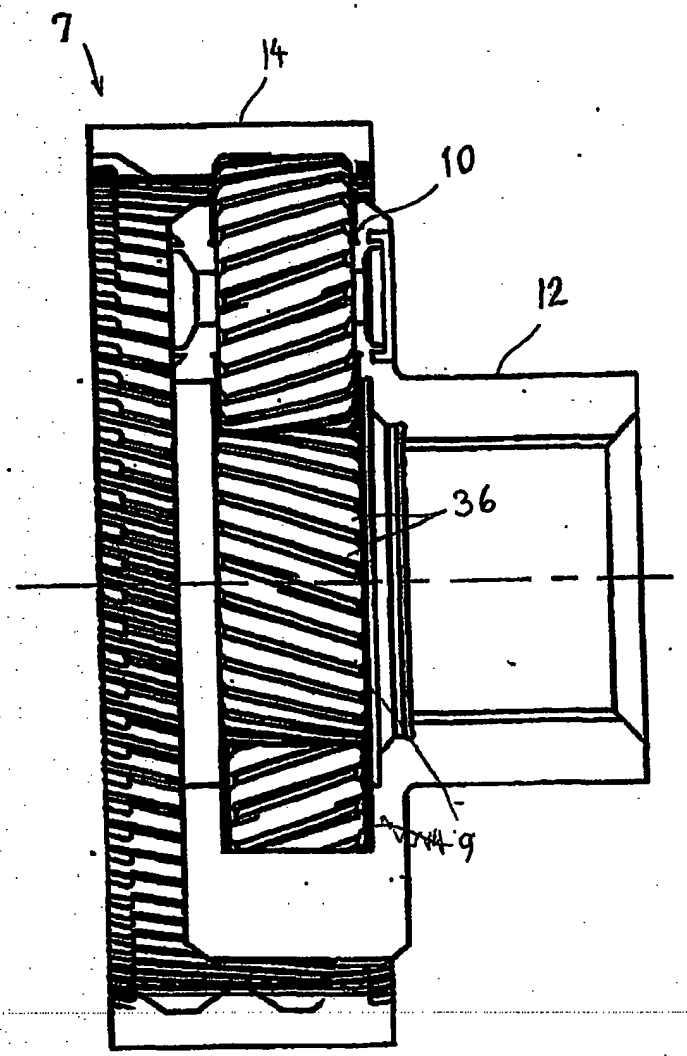
FIG. 2



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/00113

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F16H 37/04, F16H 3/54, F16H 3/78
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F16H, B60K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5390347 A (G. BURI ET AL), 14 February 1995 (14.02.95) --	1-8
A	US 4922767 A (I. TOSHIFUMI), 8 May 1990 (08.05.90) --	1-8
A	US 4667538 A (L. LARSSON), 26 May 1987 (26.05.87) --	1-8

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 August 2001	28 -08- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Per-Olof Warnbo/MN Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 01/00113

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

02/08/01

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